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the people of NPA

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Rare Metals: The Promise of Tomorrow's Industry

by J. Carlton Ward, Jr. *President, Vitro Corporation of America*
Member, NPA Business Committee

THE TRANSFORMATION of the so-called rare metals into servants for industry and defense is the biggest challenge facing modern metallurgy. It is as common elements that these rare metals will open the door to untold industrial possibilities in the Atomic Age.

These versatile substances, referred to collectively as the "rare metals", make strange bedfellows. They have little in common. Some are plentiful in other nations, but rare in the United States because of their strategic importance. Some aren't rare at all. Some are produced cheaply in large quantities, others by the gram at fantastic expense.

Silicon is the world's second most abundant element. On the other end of the scale, rhenium appears in the earth's crust at a rate of one thousandth of a gram per ton. Manmade metals like promethium, produced only in nuclear reaction, aren't found in nature at all.

No less striking is the range of physical properties exhibited by these uncommon metals. Thallium is so soft you can scratch it with your fingernail. One of its associates in the rare metals category is osmium, the hardest metal known. Gallium has such a low melting point it will literally melt in your mouth. Tungsten melts at 6,152 degrees F. Textbooks could be written on the variations in their ages, chemical and electrical properties and nuclear behavior.

EVEN MORE confusing is the fact that we include in this group the metalloids, which aren't truly metal or nonmetal; the rare earths, which are neither rare nor earths; and the trans-uranics.

Despite the confusion, there is little doubt that these so-called rare metals represent the promise of the future in the metals industry.

Rare earths, for instance, occur with thorium as phosphates in monazite sand deposits in Florida, Idaho, and South Africa and

Planning

● Planning is not new; it is as old as man himself. Many of America's problems in the 20th century point in one direction: regional planning. The typical family man wants a plot of green ground and space to raise his family. Municipal officials want moderate urban and town structures which can supply the necessary hygienic, physical and recreational services without undue fiscal and administrative problems. American industry prefers sleek plants of modern design in a suburban location where taxes are low, employee morale high and congestion at a minimum. Finally, our planners seek the greatest decentralization of population and industry as a deterrent to a possible atomic Pearl Harbor.

● Man can choose and shape his environment. Once he does, however, he becomes part of it, and it begins to shape him. That is why planning is so important.

●

From an article, "Cities of Tomorrow," by Neil P. Hurley in America, *July 13, 1957.*

bastnaesite deposits in California. High grade ores may be broken down by alkaline leaching, and low grade ores with acid. Individual rare earths are separated by ion-exchange.

Since monazite may contain ten pounds of rare earths to every pound of thorium, it is easy to see why increased thorium production is gradually lifting rare earths out of obscurity. Research has already developed a variety of uses today for rare earths. Cerium, the most prevalent of the group, dates back to the gaslight era when the rare earth industry was founded on the discovery that a colorless flame causes a thorium-oxide-cerium oxide combination to incandesce. Today, cerium is also used in its oxide form to polish glass. The hydrate is used in the production of special glass for the viewing of highly radioactive operations. It has other interesting uses.

Praseodymium imparts a rose and neodymium imparts an amethyst color to glass. Samarium and europium are employed as activators of infrared phosphors. Lanthanum is added to optical glass in aerial cameras requiring a high refractive index. Europium and gadolinium, which have high neutron absorption cross sections, have an important new corner in the nuclear field. Thulium can be made radioactive by irradiation to serve as an X-ray source in portable diagnostic devices. Praseodymium has a potential use as a coolant in the making of ceramics. Current research is aimed at the use of rare earths as catalysts in petroleum cracking plants and the manufacture of synthetic fibers and plastics.

Thorium

Thorium, which is found with rare earths in monazite, is leached to crude thorium hydroxide and purified by solvent extraction. The pure oxide or fluoride is reduced with calcium to a metallic sponge or powder, and then arcmelted into ingots.

The metal is eliminated as a structural metal by poor mechanical properties and low resistance to corrosion. It has applications as an alloy addition to other metals. That use, however, is overshadowed by the discovery that thorium can be transmuted to fissionable uranium-233 in a breeder reactor.

Lithium

Growing commercial interest in lithium is shown by the fact that only 400,000 pounds were consumed in 1944, compared with 100,000,000 pounds last year.

Lithium occurs in complex silicates in the United States and Canada, and is imported as lepidolite from South Africa. The silicates are processed by high temperature reaction in a cement-type kiln, and the metal electrolysed from a fused mixture of lithium and potassium chlorides. Its low density causes the lithium to float on the surface, from where it is ladled off and cast into ingots.

Greases containing lithium can be used in the bitter sub-Arctic cold or the blazing tropic heat and exhibit remarkable anti-water, anti-corrosion properties.

The natural element consists of two isotopes—lithium-6 (7½%), and lithium-7 (92½%). In a fusion reaction, like that used in the H-bomb, lithium-6 reacts with tritium yielding two helium nuclei and large amounts of energy. Lithium-7 with a proton can fission into helium nuclei, releasing almost three times as much energy as an equal weight of uranium-235. A nuclear reactor incorporating both the fussion reaction and uranium fission would have a greatly increased power output and would bring major changes to the atomic power industry. Lithium and its compounds are also important prospects as rocket fuels.

Titanium

Titanium's high strength, low density and excellent corrosion resistance offer countless potential applications for the metal and its alloys. Most titanium today is produced for military use.

Ilmenite, a titanium-iron oxide, and rutile (TiO_2) are the two major sources of titanium. The largest ore reserve is located in eastern Quebec with other deposits in such states as New York, Virginia, Florida, and North Carolina. The metal is often produced by the magnesium reduction of titanium tetrachloride. The metal is used for compressor blades and discs, air frames and other structural parts in jet aircraft where its low density allows considerable weight reduction.

Titanium compounds have been in use for many years. Research in only the past decade has established general principles of titanium alloy behavior and phase diagrams of the important titanium alloys.

Future applications of this metal are encouraging. Military uses under consideration include armor plate for tanks and combat vehicles, sub-

marine superstructure and snorkel tubes, and marine condensers and propellers. The chemical industry may use titanium in special valves, piping, and other equipment because of its resistance to certain types of corrosion.

Uses in automotive, marine and railroad equipment would be possible if and when the price of titanium drops into competition with stainless steel.

Other Uses for Uranium?

The main interest in uranium today is due to the metal's nuclear properties. Natural uranium contains two isotopes, fissionable U-235 (.7%), which is used as a fuel in atomic piles, and non-fissionable U-238 (99.3%). In a breeder reactor, the U-238 is transformed into fissionable plutonium, and artificial atomic fuel.

The properties of uranium indicate the metal will have limited applications outside the atomic field. It has been used as a gettering agent or "getter" in removing active gaseous impurities and for shielding against gamma-rays.

The most important known uranium ore deposits are in Canada, Australia, the Belgian Congo, Czechoslovakia and on the Colorado Plateau.

Carnotite, a domestic ore, is leached to an aqueous solution of impure uranium which is broken down by precipitation, ion-exchange or solvent extraction. The final product is a solid concentrate containing 70 percent uranium oxide (U_3O_8) which requires further purification. U_3O_8 can then be converted to UF_4, uranium tetrafluoride, which is reduced to uranium metal with magnesium, or converted to uranium hexafluoride (UF_6), for isotope separation.

Borax

New industrial applications developed by constant research promise to push borax production to new records. The metal occurs as boric acid in solution or in vapors of volcanoes or hot springs, principally in Italy. Domestic sources include borates of sodium and calcium and kernite or resorite mined in California in large quantities.

Initial production of borax in 1864 was about 12 tons compared with 468,000 tons in 1949, and 648,000 tons in 1951.

The metal is also used for motor starters, phonograph needles, thermal cutouts, thermocouples and electrical resistors. In the nuclear field, the metal is of value as a neutron absorber. The alkali-metal borohydrides and the organoborons are used as rocket fuels. Boron alloys find applications in cutting tools, high-temperature materials and wear-resisting surfaces and for fuels.

The metal is used effectively in degassing copper to produce extremely high conductive metal. Alloys find applications in cutting tools, high-temperature materials and in wear-resisting surfaces. The borides of the refractory metals are under study for resistance to extremely high temperatures.

Other Rare Metals

The use of columbium in its pure form is still under development. The metal is a superior "getter" in vacuum techniques and has specific nuclear properties for which no application has been found. Ferrocolumbium is used extensively as an alloying element, especially for the fixation of carbon in stainless steels. The carbide added to a titanium carbide cobalt cermet adds resistance to oxidation at high temperatures and is used in tungsten carbide cutting tools.

Zirconium's unusual anti-corrosion and structural properties and low neutron absorption cross-section make it an important metal in the nuclear field. Zirconium compounds have been used in poison ivy remedies, deodorants, leather-tanning agents, water-proofing materials and as chemical catalysts.

Hafnium, another rare metal found in combination with zirconium, is used in electronics for filaments, cathodes, rectifiers and as a titanium alloy and a "getter" in vacuum tubes. It is an important metal in atomic reactors.

THESE, then, are some of the more important rare metals. Their development has been goaded principally by the need for lightweight structural metals, new materials for the electronics and atomic industries and the promise of compensation for those who develop efficient techniques for their processing and fabrication. The road ahead represents a challenge to modern metallurgy for it is as common rather than rare metals that these materials will open the door to untold industrial possibilities in the Atomic Age.

International Industrial Development Conference

THE WAYS in which private industry and government can accelerate the rate of industrial development in the world's free areas, and problems of economic development common to newly developing areas pointing toward further industrialization, will be discussed at the International Industrial Development Conference to be held in San Francisco October 14 to 18.

The conference will be cosponsored by Time-Life International and the Stanford Research Institute. Eugene R. Black, president of the International Bank for Reconstruction and Development, will keynote the conference; and Henry R. Luce, editor-in-chief, Time, Inc. and member of NPA's National Council, will serve as conference chairman. More than half of the approximately 1,000 industrial, financial, and government leaders expected to attend will be coming from other countries.

PROBLEMS of both domestic and international capital will be considered. Types of private enterprise investment that lead to productive resource development, diversified economic activities, expanded job opportunities, and sound economies will be stressed during the conference. Emphasis will be placed on combining capital, resources, management, and technology in order to speed industrial development.

Over 200 industrial, banking, and economic organizations, many from the countries of the free world, are included in the list of "cooperating organizations." These include the National Planning Association, the International Bank for Reconstruction and Development, the International Finance Corporation, the European Productivity Agency, the International Development Advisory Board, the Organization of American States, and the United States Investment Bankers' Association.

(*Research for Industry News Bulletin*, Stanford Research Institute, Vol. 9, No. 3: March 1957.)

Lunken Heads Management Society

Homer E. Lunken, NPA National Council member and vice president and director of the Lunkenheimer Company of Cincinnati, Ohio, has been elected the 1957-58 president of the Society for Advancement of Management.

—The People of NPA—

Guy Emerson

NPA trustee Guy Emerson, a prominent banker, has been vice president and trustee, and is at present Director of Art of the Samuel H. Kress Foundation. In 1917, he was appointed vice president of the National Bank of Commerce in New York City, a position he held until 1923 when he became vice president of the Bankers Trust Company. Prior to these appointments, he had graduated from Harvard (1908), Harvard Law School (1911), was admitted to the Massachusetts Bar, served in the U. S. Dept. of the Treasury, was associate editor of the *Economic World* (1914-16), and organized the Episcopal Church Pension Fund for the clergy. In 1920, he wrote the study of U. S. economic conditions, *The New Frontier*. Past banking and civic affiliations include: executive manager, American Bankers Assoc. Convention in 1922 (member, executive council, 1934-38); secretary, executive committee, Emergency Employment Committee (1930-33); member, advisory committee on research in finance, National Bureau of Economic Research; president, Assoc. of Reserve City Bankers (1930); trustee, American Historical Assoc. (1928-37), and Community Service Society of New York; president, National Audubon Society (1940-44). During World War I, Guy Emerson directed publicity for Liberty and Victory Loans of the second Federal Reserve District, and was director of War Savings for the same District. His World War II service included: vice chairman, National War Fund Campaign of the Red Cross; vice chairman, executive committee, U. S. Treasury Defense Bond Committee for New York State. Since 1925, he has been treasurer of the eastern division of the Salvation Army.

Three Case Studies

Automation and Planning

AUTOMATION does not result in the overnight mechanization of an entire firm based on push buttons and robots, and designed to make workers obsolete, a recent study by the British Political and Economic Planning group (PEP) emphasizes. While some firms have introduced advanced automatic techniques, the study notes that these do not yet cover the entire operations of the firm.

In the three British industries studied—the LEO Computer, Stanlow Platformer, and a bearing tube company—advanced automation did not result in a cut in the labor force, but primarily in technical improvements.

Studying three advanced types of automation —manufacture of the bearing tubes, refining methods of the Stanlow Platformer, and the office applications of the LEO Computer—PEP shows that new techniques have increased productivity. Although direct calculation of productivity resulting from increased automation of the Platformer could not be made, it was shown that in the manufacture of bearing tubes productivity has increased over 200 percent, and the LEO can do the work of 200 to 400 clerks per shift.

THIS APPLICATION of automation did not result from a single abrupt management decision, but from detailed planning. Planning—prerequisite to automation and necessary on a day-to-day basis to ensure efficient results of automation machinery and to reduce redundancy of operations—leads to a need for more management and supervisors, PEP observed. At the same time, according to the study, more skilled maintenance workers are needed to operate the new machinery.

A report, *Automation,* published by the International Labour Office, warns against exaggerating fears of skill requirements, worker dislocation, and dismissal. Such problems can be met by planning on the part of labor and management for youth and adult training, the ILO report suggests. In none of the three PEP cases did the re-education of workers to meet automation needs present long-term problems.

The PEP case studies indicate that the worker has not been made subservient to the machine in factories where advanced automation techniques or methods have been introduced. With automation, the ILO report points out, comes the promise of higher productivity of more goods and services, of higher living standards, higher wages, shorter hours and increased leisure. Both studies stress the planning by labor and management necessary to minimize dislocation and dismissal problems. Government, too, the ILO report notes, can help to minimize dislocation.

Automation, through the operation of automatic machines by groups, promotes a vital element of worker relations—teamwork. This, according to the ILO report, may eliminate some of the strains suffered by workers in mass production, working at a machine-set pace. PEP's case studies showed that management, supervisors, operatives, and maintenance engineers did become part of one team, in order to get the best results from automatic techniques. Teamwork, the ILO report says, may result in a social gain that is hand-in-hand with economic advance.

Automation is not new, the ILO report says, but makes new industrial developments possible, such as giant oil refineries, the commercial utilization of atomic energy, continuous flow production, and (theoretically) automatic factories.
(*Three Case Studies in Automation,* Political and Economic Planning, London: July 1957, 58 pp.; *Automation,* International Labour Office, Washington, D. C.: 1957, 27 pp.)

STANVAC in Indonesia

THE good working partnership which has developed between the Standard-Vacuum Oil Company and the Republic of Indonesia—based on mutual good will and cooperation in solving problems inherent in operating foreign-owned enterprises—is described in the NPA study *STANVAC in Indonesia,* sixth in a series on United States Business Performance Abroad.

The report discusses the past impact of Standard-Vacuum's Indonesian subsidiaries on the country's economic and social development, as well as prospects for the future. The company, known as "STANVAC" in many areas of the

world, maintains three subsidiaries in Indonesia —one for oil exploration, production, and refining; one for marketing; and one for tanker transport—whose major installations are in Central and South Sumatra.

The study points out that STANVAC has added to Indonesian social progress through its activities in housing, medical facilities, and training for its Indonesian employees and their families.

Economic development in Indonesia has been spurred by development of oil fields—most of them in virgin jungle—which has opened new frontiers for settlement and for industry. The company has made substantial contributions to the national economy, too, through taxes and foreign exchange earnings.

Further exploration and development rights are needed, however, to enable STANVAC to maintain and increase its investment in Indonesia's future, the study points out. Grants for new rights are under consideration by the Indonesian government.

The report was prepared by The Indonesia Project, Center for International Studies, Massachusetts Institute of Technology.

(*STANVAC in Indonesia,* NPA, Washington: June 1957, 144 pp., $1.00.)

Economic Developments in the Middle East

DURING 1955-56, the demand for Middle Eastern exports continued in an upward trend, particularly exports of petroleum and cotton. According to the recently published *UN Economic Developments in the Middle East, 1955-1956,* the USSR and east European countries claimed a larger proportion of these exports while the volume and value of exports to western Europe declined. In this report, the Middle East is considered to include Egypt, Iran, Iraq, Israel, Jordan, Lebanon, Saudi Arabia, the Sudan, Syria, Turkey and Yemen; Aden Colony, Aden Protectorate, Bahrain, Cyprus, Kuwait, Muscat and Oman, Quatar and the Trucial Coast.

Capital investment in the petroleum industry rose from $190 million in 1954, to $210 million in 1955, and was largely financed through reinvestment of profits. Turkey and Israel were the primary recipients of private capital inflow to the area, but grants and loans to the countries of the Middle East from the United States and other governments increased.

From 40 to 50 percent of the national income of these countries is derived from agriculture. Progress has been made, in recent years, in placing more of the cultivated land under irrigation and in overcoming institutional and technical obstacles to increased agricultural production. Agricultural yield is still subject to the vagaries of climate which, in 1955-56, were more pronounced than in previous years. For example, Turkey provides nearly half of the area's grain crop and both 1955 and 1956 were poor years. In other countries, crops were fairly good in 1956. The cultivable area devoted to cotton increased more than that devoted to grain; overall cotton production increased by 5 percent over 1954.

Improvement has also been noted in the use of chemical fertilizers and pesticides and in distribution of improved seeds and animal breeds. Mechanization of agriculture has proceeded quite rapidly. The number of tractors in use in the area was nearly three times that of 1950. It should be noted that approximately two-thirds of these tractors were located in Turkey.

Industry in the Middle East as a whole continued to expand, although the rate of development was uneven from one country to another. Throughout 1956, Israel and Syria experienced export problems and Egypt and Turkey suffered from shortages of foreign exchange for imports of raw materials. Foreign capital could play an important role in the industrial development of the area, but, with the exception of Turkey and Israel, little has been attracted to fields other than the petroleum industry.

The report contains an analysis and preliminary survey of the effect of the Suez Canal crisis on the economy of the Middle East. Inflationary pressures existed in the Middle East in 1955, and the Suez crisis accentuated these pressures. Government expenditures for defense purposes increased to such an extent that the ordinary budgetary revenues were not adequate. Food prices continued to rise due to the generally poor harvests in 1955, and the military operations in 1956. The crisis affected oil-producing countries, resulting in changes in patterns of oil production, transport, and revenue. However, the interruption did not seriously alter development projects in these countries. R. M.

(*UN Economic Developments in the Middle East, 1955-1956,* United Nations, New York: May 1957, 135 pp., $1.50.)

American Influences on British Education

UNLIKE the time-worn British stereotype, U. S. educational ideas have not catered to vulgarity and mediocrity, but have progressively adapted to modern needs, a recent article in the British Association for the Advancement of Science's monthly publication points out. Moreover, their influence is being keenly felt in British secondary schools and colleges.

This influence, evident in recent expansion of British technical schools, is traced from the early 1800's by British professor W. H. G. Armytage.

The matrix of British modern education is Atlantic rather than Continental, Armytage contends. Armytage traces pre-twentieth century influences from the arrival of Francis Gilmer—Jefferson's representative who stimulated the founding of the University of London along Jeffersonian lines. He also covers the later founding of the Lancashire Public School Association (the school board system) inspired by American exponent Richard Cobden, the establishment of technical education based on U. S. practice in 1882, and the creation of the Department of Special Inquiries and Reports (1895) modeled after the U. S. Department of Education.

PRIOR to the twentieth century, British educators visited the U. S. to observe secondary education programs. Visiting Boston, Philadelphia, New York, Connecticut, and Rhode Island, they were, generally, favorably impressed with the curricula and facilities. J. R. Godley, a Tory and not an admirer of America, was "astonished" to see that the speaking and writing ability of the Negro students he viewed in New York was "far superior to that of the English working classes." Colleges and universities provoked mixed feelings, Armytage states, alternating with praise for their inexpensiveness and condemnation of their narrow vocationalism.

More recently, this vocational education approach has become very important to the British as they view American productivity. Many observers have visited the U. S. from various Commonwealth countries. One—Alfred Mosley—after observing the teaching of technical skills, encouraged a study group to visit U. S. technical schools. They reported in a Labour Commission Report: "One of the principal reasons why the American workman is better than the Britisher is that he has received a senior and better education. . ."

U. S. influence has also been felt through the expansion of universities and libraries in Great Britain made possible by Carnegie and Rockefeller endowments.

ANOTHER U. S. INFLUENCE—new ideas in applying psychological testing—spread to Great Britain in the 1930's through the wide circulation and reading of U. S. journals of child psychology.

Derek Colville, a Britisher now teaching at Yale, points out in the October issue of *Harper's* that the British system has been producing a tiny minority for university training; it has acted as a "patrician system selecting a small intellectual aristocracy." The American system, he observes, strives to be "democratic throughout." The U. S. idea to educate everybody was brought to Great Britain from the U. S. in the Gary Plan, Winnetka Technique, the Project Method and the Dalton Plan—secondary school ideas—which were modified and accepted in the new British secondary schools, according to Armytage.

Professor Armytage emphasizes that the U. S. has helped the British adjust to modern life by "pulling at the class layers of British society . . . destroying the amateur British farmer . . . and with American inventions, supplanting the expensive English handicraft worker." The pace of U. S. technological change has precipitated solutions of social problems long shelved in British industrial areas, Armytage says. U. S. education has met these problems, and, he concludes, has spurred the conscience of British education for the past century and a quarter.

(*The Advancement of Science,* "Some Aspects of American Influence of British Education," W. H. G. Armytage, London: March 1957; *Harper's,* "British and American Schools," Derek Colville, New York: October 1957.)

The Practice of Unionism

IN *The Practice of Unionism—An Inside Picture of Labor Unions Today,* author Jack Barbash points out that although the rapidly increasing organization of workers into industrial and multi-plant unions fell off after the 1947 Taft-Hartley Law and restrictive state legislation, certain points of union development continued.

A "common ground" of ideas and practices among unions has grown; union interest in politics, legislation, and international affairs has increased; the scope of collective bargaining is widening. Unions are developing more initiative in shaping union-management relations, and developing more business-like administration.

Studying these continuing developments, Barbash, past union member and staff employee, and now professor of labor education at the University of Wisconsin, outlines the structure and functions of present-day unions. He discusses the tactics organizers use to establish new unions, the levels of union organization and the way unions are governed on each level, how and why union discipline is enforced, the stages of collective bargaining, and the growth of union-management attitudes in collective bargaining.

Discussing the growth of good working relationships between unions and management, Barbash says: "There is the collaborative employer who is likely to regard the collective bargaining relationship as a challenge to human relations. . . . Many of the employer subjects of the National Planning Association series on the *Causes of Industrial Peace* have viewed the union from this perspective."

Barbash underlines the factors that have been important in bringing about better employer-labor understanding. These factors include the addition to the administration of companies of labor relations professionals to work in the collective bargaining process, and the work of unions to encourage the mutual respect of employers and workers.

Barbash points out other recent developments in the leadership techniques and educational programs of unions, with illustrations from union sources.

(*The Practice of Unionism,* by Jack Barbash; Harpers Bros., New York: 1957, 465 pp. $5.00.)

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